PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :
F23R 3/10, 3/54, F23M 5/08, F23R 3/50

A1

(11) International Publication Number: WO 99/61841

(43) International Publication Date: 2 December 1999 (02.12.99)

(21) International Application Number: PCT/SE99/00883

(22) International Filing Date: 25 May 1999 (25.05.99)

(30) Priority Data:
9801822-9 25 May 1998 (25.05.98) SE

(71) Applicant *(for all designated States except US)*: ASEA BROWN BOVERI AB [SE/SE]; S-721 83 Västerås (SE).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: NAVROTSKY, Vladimir [RU/SE]; Oxhagsvägen 10 D, S-612 32 Finspång (SE). REKIN, Anatoli [RU/RU]; Marshala Vasilevskogo 15/1, 90, Moskva, 123182 (RU).

(74) Agents: BERGLUND, Stefan et al.; Bjerkéns Patentbyrå KB, Östermalmsgatan 58, S-114 50 Stockholm (SE).

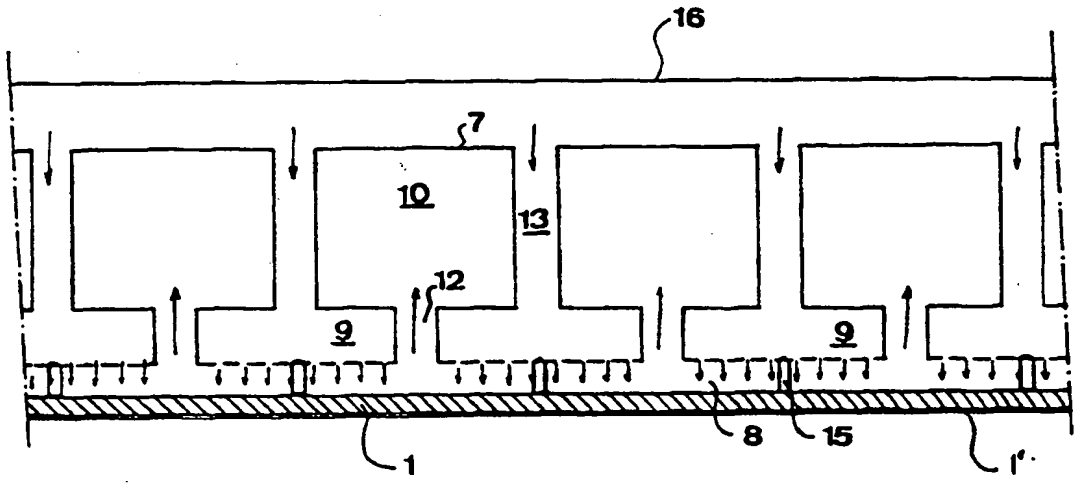
(81) Designated States: AL, AM, AT, AT (Utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), EE, EE (Utility model), ES, FI, FI (Utility model), GB, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published

With international search report.

Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: COOLING ARRANGEMENT FOR COMBUSTION CHAMBER



(57) Abstract

The invention refers to a combustion device comprising a wall arrangement having a first inner wall member (1) and a second wall member (7). The first wall member defines a combustion chamber (2) and is essentially continuous. The second wall member (7) is provided outside the first wall member and forms a space (8) between the first and second wall members. In order to cool down the combustion chamber, the second wall member comprises a great number of holes arranged to direct jets of a cooling fluid onto a main part of the outer surface of the first inner wall member (1).

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon			PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

Cooling arrangement for combustion chamber

THE BACKGROUND OF THE INVENTION AND PRIOR ART

The present invention refers to a combustion device comprising a wall arrangement having a first inner wall member, defining a combustion chamber, and a second wall member, provided outside the first inner wall member and forming a space between the first and second wall members, the second wall member comprising a great number of holes arranged to direct jets of a cooling fluid onto a main part of the outer surface of the first inner wall member.

The combustion device according to the present invention is described in the following in connection with a combustion chamber for a gas turbine. However, the combustion device is applicable also to combustion chambers for other purposes.

Traditionally, such gas turbine combustion chambers are defined by a combustion chamber wall having a great number of holes to permit cooling air to enter the combustion chamber and to form a thin cooling air layer on the inside surface of the combustion chamber wall.

However, such introduction of cooling air will reduce the temperature of the combustion gases at the inlet of the turbine, and to compensate for such a temperature reduction, the temperature of the flame is raised, since the efficiency of the gas turbine is determined by the temperature of the combustion gases at the inlet of the turbine. However, if

the temperature of the flame is raised, the formation of NO_x is significantly increased. In order to meet the environment requirements, it is consequently desirable to maintain a flame temperature which is as low as possible to keep the NO_x-emissions on a low level.

Although, it has been proposed to dispense with the cooling air introduction through the combustion chamber wall, such a solution is not commercialised due to the problems to provide sufficient cooling of the combustion chamber wall.

JP-A-09041991 discloses a combustion device comprising a wall arrangement having a first inner wall defining a combustion chamber. A second wall is provided outside the first inner wall and forms a space between the first wall and the second wall. The second wall comprises a great number of holes arranged to direct jets of a cooling fluid onto a main part of the outer surface of the first wall. The first wall comprises inlet apertures for conveying combustion air into the combustion chamber.

SUMMARY OF THE INVENTION

The object of the present invention is to provide a combustion chamber, in which the cooling of the combustion chamber wall is improved.

This object is obtained by a combustion device comprising a wall arrangement having a first inner wall member, defining a combustion chamber, and a second wall member, provided outside the first inner wall member and forming a space between the first and second wall members, the second wall member comprising a great number of holes arranged to direct jets of a cooling fluid onto a main part of the outer surface of the first inner wall member, wherein the first inner wall member is essentially continuous. By means of

such jets of a cooling fluid onto almost the complete combustion chamber wall, it is possible to provide full convection cooling of the combustion chamber so that the first wall member may remain essentially continuous or closed, i.e. to dispense with essentially all introduction of air into the combustion chamber except through the burner. The jets of cooling fluid will impinge onto the outer surface and thus provide a high cooling effect in relation to the mass flow. Preferably the first inner wall member may be formed by an essentially continuous metal sheet.

According to an embodiment of the invention, the second wall member comprises a number of outlet passages arranged to convey said fluid away from said space into at least one collecting channel. By such passages, the cooling fluid may be removed from said space in a convenient manner, improving the cooling effect of the jets of cooling fluid. Such a collecting channel may be arranged to convey at least a main part of said fluid to a burner of the combustion chamber in such a manner that the fluid, which contains oxygen, is introduced into the combustion chamber through the burner. In particular, the combustion chamber is essentially closed and comprises an outlet for combustion gases and a number of burners arranged to convey essentially all of said oxygen-containing fluid to the interior of the combustion chamber. Consequently, all cooling fluid may be employed as combustion air in the combustion zone of the combustion chamber. Furthermore, said collecting channel may be arranged to convey said fluid in a direction essentially opposite to the flow direction within the combustion chamber.

According to a further embodiment of the invention, the second wall member comprises wall portions through which said holes extend and between which said passages extend.

Such perforated wall portions may have an elongated shape and extend essentially in parallel to each other and to the flow direction within the combustion chamber, i.e. in the longitudinal direction of the combustion chamber.

According to a further embodiment of the invention, a number of distributing channels are arranged to distribute said fluid to the holes of the respective wall portion and are each partly defined by such a wall portion. Thus, a distributing channel is provided radially outside each such wall portion, which ensures an efficient supply of the cooling fluid to said space via the holes in the wall portion. Moreover, a number of collecting channels may be provided, wherein the collecting channels and distributing channels extend essentially in parallel to each other. Thereby, the collecting channels and the distributing channels may advantageously extend in such a manner that every second channel is a distributing channel, supplying cooling fluid, and every second channel is a collecting channel, removing used cooling fluid.

According to a further embodiment of the invention, the second wall member comprises a metal sheet shaped in a meander-like manner to form said distributing and collecting channels and to be resilient in a direction perpendicular to the direction of the channels. Such a meander-like or bellow-like metal sheet is flexible in a tangential direction in such a manner that it may expand and thus follow the thermal expansion of the combustion chamber during operation thereof. A normal external overpressure will keep the metal sheet and thus the second wall member tight against the first inner wall member defining the combustion chamber. By means of such a meander-shaped second wall member, inlet passages may be provided to introduce said fluid into the distributing channel and extend in parallel to the direction of the channels, in such a manner

that such an inlet passage extends between every second collecting channel. Preferably, essentially each distributing and collecting channel has a rectangular shape seen in a cross-section perpendicular to the direction of the channels.

According to another embodiment of the invention, said distributing channel comprises a conduit member separated from the conduit member of adjacent distributing channels. Such a conduit member may be shaped as a separate, longitudinal box, one side wall of which forms said perforated wall portion. Thereby, an inlet opening may be provided in an end area of the conduit member. Advantageously, the cross-sectional area of said conduit member is decreasing from said inlet opening along the extension of the distributing channel. By such a feature it is possible, if the pressure changes along the combustion chamber, to keep the pressure drop between the distributing channel and the collecting channel essentially constant. Thereby, a third wall member is provided outside said conduit members, wherein said collecting channel is defined by the first and third wall members.

According to a further embodiment of the invention, distance members are provided between the second wall member and the first inner wall member, and arranged to determine the distance from said holes to the outer surface of the first inner wall member. By such distance members, the cooling effect of different parts of the combustion chamber may be adjusted. Thereby, said distance members may be attached to the wall portions and slideable in relation to the first inner wall portion. Consequently, the first inner wall member may be self-supported without any fix, for instance welded, connections to the surrounding second wall member.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is now to be explained in connection with different embodiments, merely described by way of examples, and with reference to the drawings attached.

Fig 1 discloses a longitudinal sectional view of a combustion device according to the invention.
Fig 2 discloses a cross-sectional view along the line II-II in Fig 1.
Fig 3 discloses a cross-sectional view along the line III-III in Fig 1.
Fig 4 discloses a cross-sectional view along the line IV-IV in Fig 1.

DETAILED DESCRIPTION OF DIFFERENT EMBODIMENTS

Fig 1 discloses a combustion device comprising a first inner wall 1 defining an inner space forming a combustion chamber 2. The first inner wall 1 comprises a metal sheet having an inner ceramic layer 1', see Figs 2-4. The combustion chamber 2 is intended to produce hot combustion gases for a turbine of a gas turbine plant.

The combustion chamber 2 has an inlet portion supporting a burner 3 which is supplied with combustion air through apertures 4 and with fuel through fuel conduits 5. Moreover, the combustion chamber 2 has an outlet 6 forming the inlet of the turbine. The first inner wall member 1 is essentially continuous in such a manner that the combustion chamber 2 is essentially closed, i.e. essentially all air supplied enters the combustion chamber 2 through the burner 3.

The combustion chamber 2 may have any suitable shape, for instance the combustion chamber 2 may be annular, forming a torus-like space about a rotational axis of a gas turbine

rotor, or combustion chamber 2 may be shaped as a cylinder. In case the combustion chamber is annular, a number of burners may be provided distributed around the rotational axis.

Fig 1 illustrates two embodiments of the invention, a first embodiment is disclosed in the upper part of the Fig 1 and in Fig 2, and a second embodiment is disclosed in the lower part of Fig 1 and in Figs 3 and 4. However, it is to be noted that a single one of these embodiments may be applied to a combustion device, although it is also possible that these different embodiments may be applied to different parts of one combustion device, as disclosed in Fig 1, for instance the first embodiment to the outer periphery of an annular combustion chamber and the second embodiment to the inner periphery of such an annular combustion chamber.

With reference to the first embodiment and Figs 1 and 2, a second wall member 7 is provided and forms a space 8 between the second wall member 7 and the first inner wall member 1. The second wall member 7 comprises a metal sheet plastically bent to a meander-like or bellow-like shape in such a manner that distributing channels 9 and collecting channels 10 are formed, wherein every second channel is a distributing channel 9 and every second channel is a collecting channel 10. Seen in a cross-sectional view, the distributing channels 9 and the collecting channels 10 have an essentially rectangular shape. The metal sheet 7 has wall portions 11, each forming a side wall of such a distributing channel 9 and having a great number of holes or being perforated, as appears from the figures. The wall portions 11 are essentially parallel to the first inner wall member 1 and provided at certain distance from the first wall member 1. Due to the shape of the metal sheet 7, the wall portions 11 are separated from each other in such a manner that an outlet passage 12 is formed between every second wall

portion 11 and distributing channel 9. Each outlet passage 12 connects the space 8 to a respective collecting channel 10. Moreover, an inlet passage 13 is formed between every second collecting channel 10 and connects the surrounding space to the distributing channel 9. As appears from Fig 1, the collecting channels end in a collecting chamber 14 surrounding the burner 3.

The distributing channels 9, the collecting channels 10, the wall portions 11, the outlet passages 12 and the inlet passages 13 all have an elongated shape extending in parallel to each other, to an longitudinal axis x of the combustion chamber 2, and to the main gas flow direction within the combustion chamber 2.

The second wall member 7, i.e. the wall portions 11, is arranged at a determined distance from the outer surface of the first inner wall member 1 by means of distance members 15 provided between the second wall member and the first inner wall member. The distance members 15 are attached to the wall portions 11 and slideable in relation to the first inner wall portion 1. By such a distance members 15, the distance from the holes of the wall portions 11 to the outer surface of the first inner wall member 1 may be maintained on a certain level ensuring a certain cooling effect.

Outside the second wall member 7, a third outer wall member 16 is provided to enclose the second wall member 7, forming a intermediate wall member, so that an intermediate space is formed therebetween. The third wall member 16 comprises at least one inlet opening 17 arranged in a forward part of the combustion device to convey the combustion air into said intermediate space.

In a gas turbine application, combustion air will be supplied, via the inlet opening 17, to said intermediate

space surrounding the combustion device by means of a compressor (not disclosed) in such a manner that the combustion air has a higher pressure than within the combustion device. Consequently, combustion air is forced from the surrounding intermediate space into the distributing channels 9 via the inlet passages 13. From the distributing channels 9, the combustion air is conveyed through the holes of the wall portions 11 into the space 8 in such a manner that the jets of air impinge the outer surface of the first inner wall member 1. From the space 8, the combustion air is conveyed or forced into the collecting channels 10 via the outlet passages 12. The collecting channels 10 convey the combustion air in a direction opposite to the direction of the main gas flow within the combustion chamber 2 into the collecting chamber 14. From the collecting chamber 14, the combustion air is forced into the combustion chamber 2 via the apertures 4 and the burner 3.

Due to the shape of the metal sheet 7, the second wall member 7 has a substantial resiliency in a tangential direction or a direction perpendicular to said direction of the channels 9, 10. Thus, the second wall member 7 may expand when the first inner wall member 1 expands due to a raised temperature during operation of the combustion device. In order to maintain the distance members 15 in contact with the outer surface of the first inner wall member 1, a circumferential band or wire in combination with a spring may be arranged around the outer periphery of the second wall member 7.

With reference to the second embodiment, disclosed in the lower part of Fig 1 and in Figs 3 and 4, the third outer wall member 16 is provided outside the first inner wall member 1 in such a manner that said intermediate space is formed therebetween. In the intermediate space, conduit

members 18 are provided separately and at a distance from each other in such a manner that the conduit members 18 form the second wall member 7 defining the space 8 and have a box-like shape and are essentially rectangular seen in a cross-sectional view. Furthermore, the conduit members 18 are elongated and extend in a direction parallel to the longitudinal axis x.

Each conduit member 18 defines a distributing channel 9 and has a side wall forming a perforated wall portion 11 being essentially parallel to the first inner wall member 1 as in the first embodiment. Each conduit member 18 has an open end facing away from the burner 3 and forming an inlet passage 13 for the combustion air, which is forced through the third outer wall member 16 via the inlet opening 17.

The intermediate space, in which the conduit members 18 are positioned, defines a collecting channel 10 between an outer side wall of the conduit members 18 and the inner surface of the third outer wall member 16. The spaces between adjacent conduit members define the outlet passages 12.

The cross-sectional area of each conduit member 18 decreases from the inlet passage 13 along the extension of the conduit member 18.

In the second embodiment of a gas turbine application, combustion air will be forced through the inlet opening 17 into the distributing channels 9 of the conduit members 18. From the distributing channels 9, the combustion air is conveyed through the holes of the wall portions 11 into the space 8 in such a manner that the jets of air impinge the outer surface of the first inner wall member 1. From the space 8, the combustion air is conveyed or forced into the collecting channel 10 defined by the third wall member 16 via the outlet passages 12 between adjacent conduit members

18. The collecting channel 10 convey the combustion air in a direction opposite to the direction of the main gas flow within the combustion chamber 2 into the collecting chamber 14 in a similar manner as in the first embodiment.

The present invention is not limited to the embodiments disclosed but may be varied and modified within the scope of the following claims. It is to be noted that if the combustion chamber has an annular shape, each of the first wall member, the second wall member and the third wall member comprises an inner wall part extending around a centre axis and an outer wall part extending around said centre axis concentrically with regard to the inner wall part.

Claims

1. A combustion device comprising a wall arrangement having a first inner wall member (1), defining a combustion chamber (2), and a second wall member (7), provided outside the first inner wall member and forming a space between the first and second wall members (1, 7), the second wall member comprising a great number of holes arranged to direct jets of a cooling fluid onto a main part of the outer surface of the first inner wall member (1), wherein the first inner wall member (1) is essentially continuous.

2. A device according to claim 1, wherein the first inner wall member is formed by an essentially continuous metal sheet.

3. A device according to any one of claims 1 and 2, wherein the second wall member (7) comprises a number of outlet passages (12) arranged to convey said fluid away from said space (8) into at least one collecting channel (10).

4. A device according to claim 3, wherein said collecting channel (10) is arranged to convey at least a main part of said fluid to a burner (3) of the combustion chamber in such a manner that the fluid, which contains oxygen, is introduced into the combustion chamber through the burner (3).

5. A device according to claim 3, wherein the combustion chamber is essentially closed and comprises an outlet for combustion gases and a number of burners arranged to convey essentially all of said oxygen-containing fluid to the interior of the combustion chamber.

6. A device according to any one of claims 3 to 5, wherein said collecting channel (10) is arranged to convey said

fluid in a direction essentially opposite to the flow direction within the combustion chamber (2).

7. A device according to any one of the preceding claims, wherein the second wall member (7) comprises wall portions (11) through which said holes extend and between which said outlet passages (12) extend.

8. A device according to claim 7, wherein said wall portions (11) have an elongated shape and extend essentially in parallel to each other and to the flow direction within the combustion chamber (2).

9. A device according to any one of claims 7 and 8, wherein a number of distributing channels (9) are arranged to distribute said fluid to the holes of the respective wall portion and are each partly defined by such a wall portion (11).

10. A device according to claims 3 and 9, wherein a number of collecting channels (10) are provided and the collecting channels (10) and distributing channels (9) extend essentially in parallel to each other.

11. A device according to claim 10, wherein the collecting channels (10) and the distributing channels (9) extend in such manner that every second channel is a distributing channel and every second channel is a collecting channel.

12. A device according to any one of claims 10 and 11, wherein the second wall member (7) comprises a metal sheet shaped in a meander-like manner to form said distributing and collecting channels (9, 10) and to be resilient in a direction perpendicular to the direction of the channels.

13. A device according to any one of claims 9 to 12, wherein inlet passages (13) are provided to introduce said fluid into the distributing channels (9), said inlet passages (13) extending in parallel to the direction of the channels.

14. A device according to claim 13, wherein such an inlet passage extends between every second collecting channel (10).

15. A device according to any one of claims 10 to 14, wherein essentially each distributing and collecting channel (9, 10) has a rectangular shape seen in a cross-section perpendicular to the direction of the channels.

16. A device according to any one of claims 1 to 9, wherein said distributing channel (9) comprises a conduit member (18) separated from the conduit member of adjacent distributing channels.

17. A device according to claim 16, wherein said distributing channel (9) has an inlet opening (13) provided in end area of the conduit member (18).

18. A device according to claim 17, wherein the cross-sectional area of said conduit member (18) is decreasing from said inlet opening (13) along the extension of the distributing channel (9).

19. A device according to any one of claim 16 to 18, wherein a third wall member (16) is provided outside said conduit members (18), said collecting channel being defined by the first and third wall members (16).

20. A device according to any one of the preceding claims, wherein distance members (15) are provided between the

second wall member (7) and the first inner wall member (1), and arranged to determine the distance from said holes to the outer surface of the first inner wall member (1).

21. A device according to claims 7 and 20, wherein said distance members (15) are attached to the wall portions (11) and slideable in relation to the first inner wall portion (1).

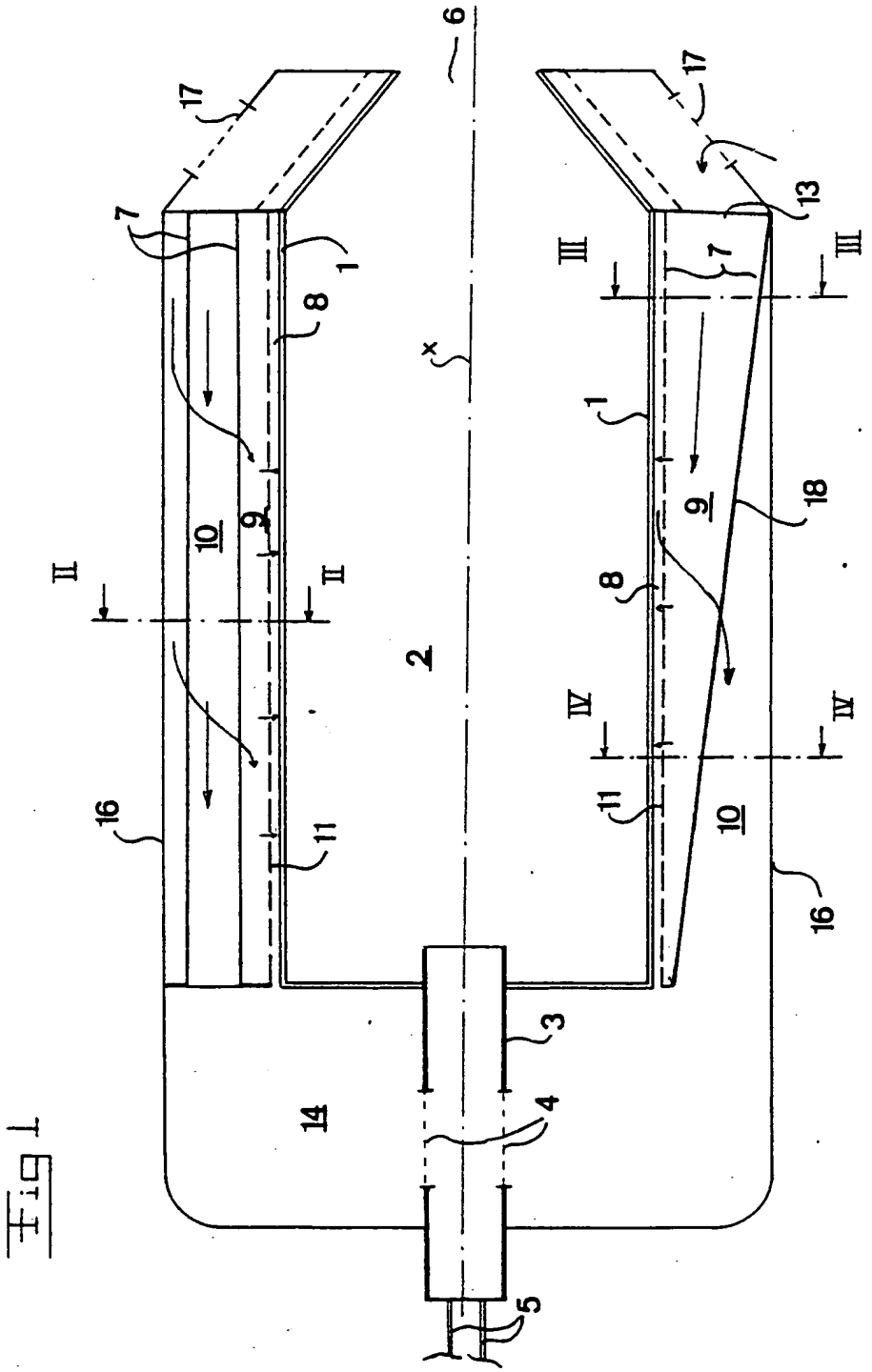


Fig 1

Fig 2

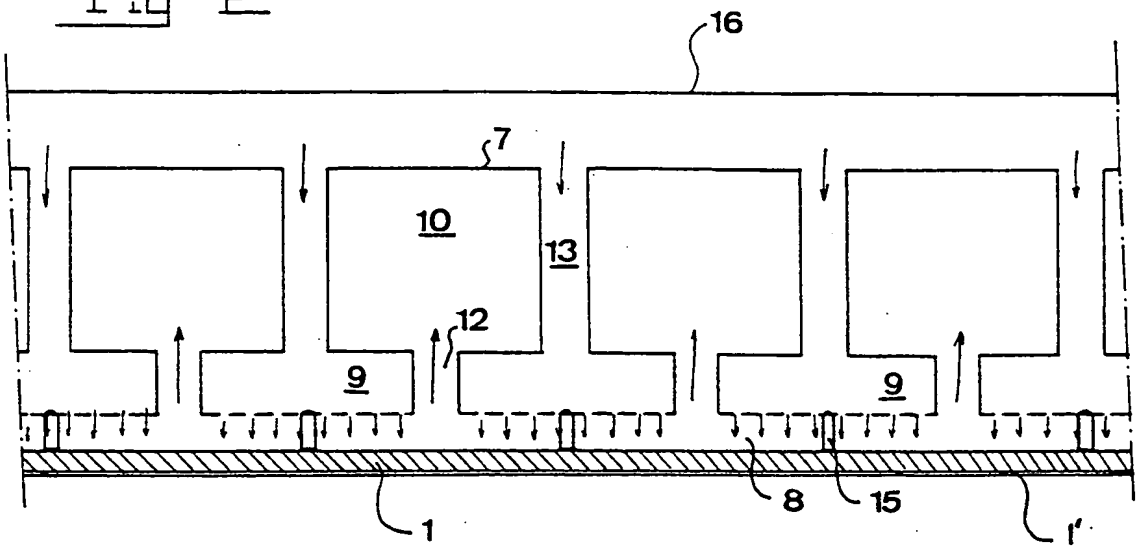


Fig 3

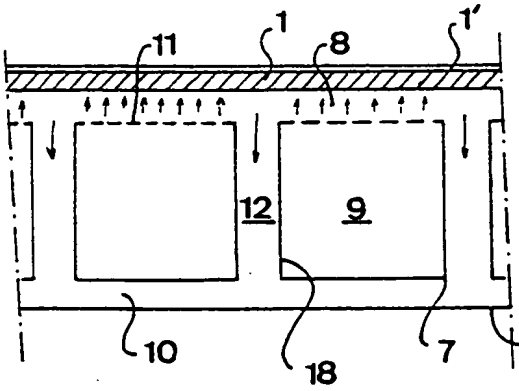
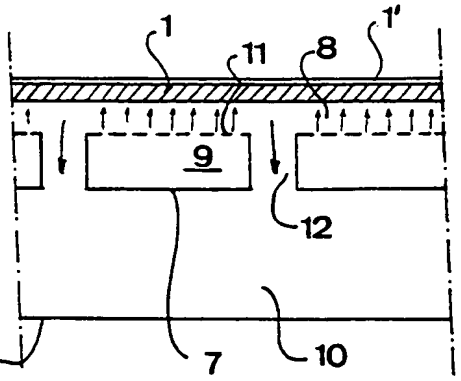


Fig 4



INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 99/00883

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: F23R 3/10, F23R 3/54, F23M 5/08, F23R 3/50
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: F23M, F23R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 9041991 A (TOSHIBA CORP.), 10 February 1997 (10.02.97), figures 1-12	1-17,19-21
Y		18
	--	
X	Patent Abstracts of Japan, abstract of JP 9-41991 A (TOSHIBA CORP.), 10 February 1997 (10.02.97)	1-11,13,14
	--	
X	SU 1812390 A1 (NAUCHNO-PROIZVODSTVENNOE OBEDINENIE PO ISSLEDOVANIYO I PROEKTIROVANIYO ENERGETICHHESKOGO OBORUDOVANIYA IM. I I. POLZUNOVA), 30 April 1993 (30.04.93), figures 1-3	1,3,4,6-9, 16,17
	--	

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 August 1999	27-09-1999
Name and mailing address of the ISA/	Authorized officer
Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Anders Bruun / MR Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 99/00883

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Derwent's abstract, No 94-239967/29, week 9429, ABSTRACT OF SU, 1812390 (POLZUNOV POWER EQUIP RES PRODN ASSOC), 30 April 1993 (30.04.93)	1,3,4,6-9,16
	--	
X	US 5363654 A (LEE), 15 November 1994 (15.11.94), figures 1-7	1,3,5,7-11, 13-17,20
	--	
X	US 5467815 A (HAUMANN ET AL), 21 November 1995 (21.11.95), figures 1,2	1-3,7-17
	--	
Y	US 5426943 A (ALTHAUS ET AL), 27 June 1995 (27.06.95), column 2, line 56 - line 61, figure 1	18
	--	
A	US 5388412 A (SCHULTE-WERNING ET AL), 14 February 1995 (14.02.95), figure 1, abstract	18
	--	
A	EP 0597137 A1 (ASEA BROWN BOVERI AG), 18 May 1994 (18.05.94)	
	--	
A	WO 9813645 A1 (SIEMENS AKTIENGESELLSCHAFT), 2 April 1998 (02.04.98)	
	--	

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/SE 99/00883

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 9041991 A	10/02/97	NONE	
SU 1812390 A1	30/04/93	NONE	
US 5363654 A	15/11/94	DE 69406975 D,T	28/05/98
		EP 0624757 A,B	17/11/94
		JP 2634769 B	30/07/97
		JP 7049041 A	21/02/95
US 5467815 A	21/11/95	DE 4244302 A	30/06/94
		JP 6294330 A	21/10/94
		DE 4244303 A	30/06/94
US 5426943 A	27/06/95	DE 4242721 A	23/06/94
		EP 0602384 A	22/06/94
		JP 6221562 A	09/08/94
US 5388412 A	14/02/95	DE 4239856 A	01/06/94
		DE 59306732 D	00/00/00
		EP 0599055 A,B	01/06/94
		JP 6213002 A	02/08/94
EP 0597137 A1	18/05/94	DE 59208713 D	00/00/00
		JP 6213458 A	02/08/94
WO 9813645 A1	02/04/98	EP 0928396 A	14/07/99